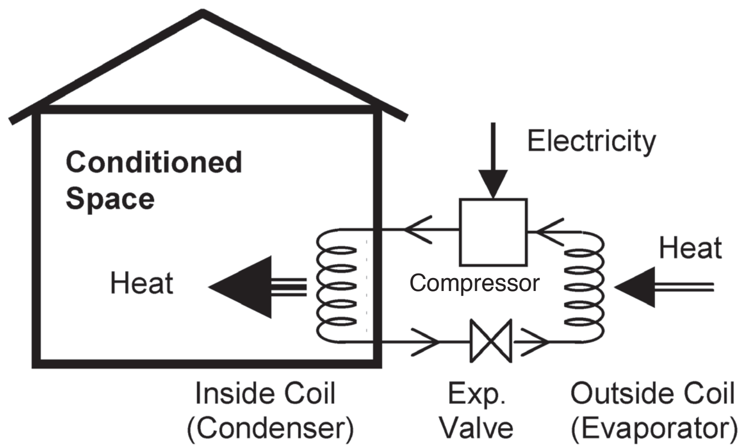
# Grounded-Coupled Heat Pumps

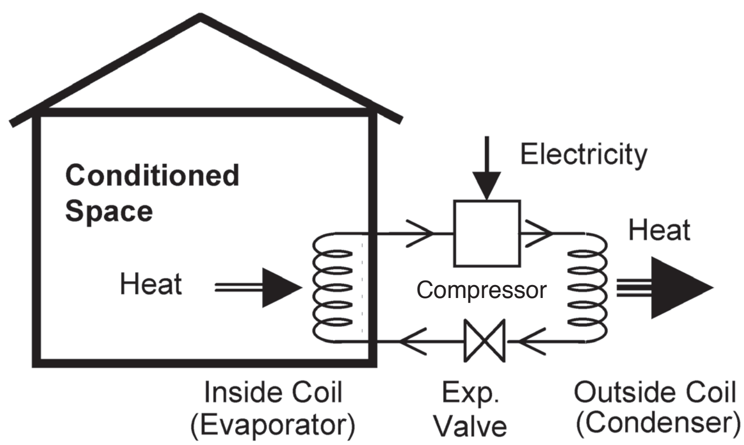
RENEWABLE ENERGY
THE INFINITE POWER
OF TEXAS

## HIGHLIGHTS

- **Heat pumps can be used to heat or cool a building**
- **Coupling the outside source of air to the ground adds greater efficiency**
- **The use of heat pumps can reduce both energy costs and emissions from saved energy generation**




**Heat pump in heating mode** *The heat pump absorbs heat at a low temperature in the evaporator and rejects it at a higher temperature from the condenser.*

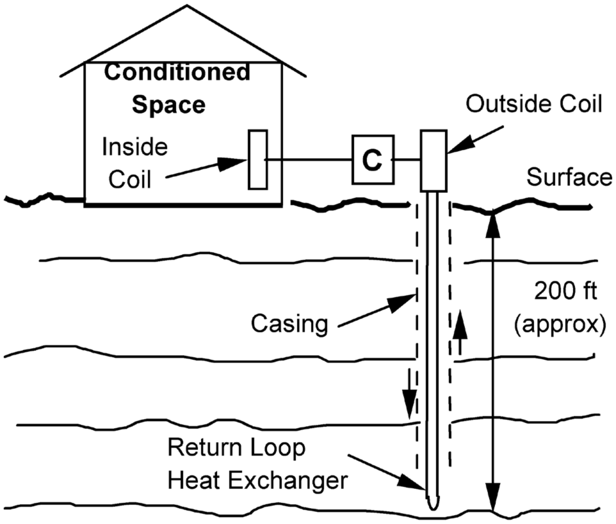



**Heat pump in cooling mode** *The direction of refrigerant flow is reversed, causing heat to be rejected from the building.*

## THE HEAT PUMP SYSTEM

Heat naturally flows from hot places to cold places. However, heat can be moved in the other direction, from cold to hot, with a heat pump, a device usually driven by an electric motor. Air conditioners transfer heat from a cool house to the hot outdoors, so in a strict sense, they are heat pumps. But in the building trades, the term heat pump refers to a special kind of air conditioner that can reverse direction, moving heat from the cold outdoors to the warm indoors. These devices can be used for both cooling and heating.

When used to heat a building, a heat pump has an interesting characteristic: it delivers to the building more energy (in the form of heat) than




**Ground coupling using bored vertical holes** *Coupling occurs with the earth using boreholes at 200 – 300 feet of depth per ton of conditioning capacity required.*

is required to run it. This is because it delivers to the building the energy used to run it PLUS whatever it can extract from the cool outdoors. Its effectiveness depends on the indoor and outdoor temperatures, but it is not uncommon for heat pumps to deliver three times as much energy in heat as they consume in electricity.

Heat pumps operate less efficiently as the temperature difference between indoors and outdoors increases. For this reason, heat pumps are less effective in very cold climates and generally include electric heating elements for those times when they just can not handle the load. There is a second problem with heat pumps. Just as an air conditioner gets cool on its inside coils, a heat pump gets cold on its outside coils when heating, and sometimes ice will form there. For this reason, heat pumps generally provide defrost cycles, switching into a cooling mode that warms the outside coils and melts the ice. Of course, defrost cycles detract from heating efficiency. These are minor difficulties, though. Heat pumps can provide a more efficient alternative to electric heating.

## GROUND COUPLING

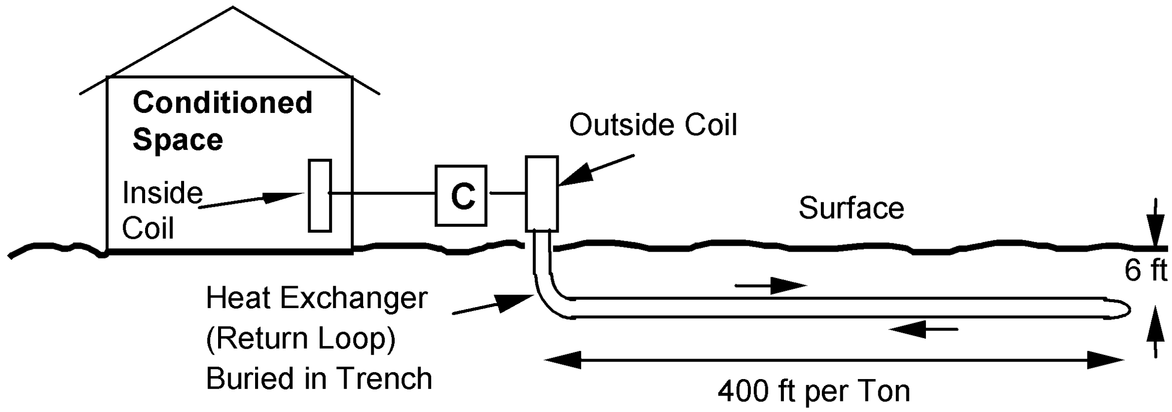
Some heat pump designs, known as "ground-coupled" designs, address the problems mentioned above by exchanging heat with the ground instead of the outside air. On cold days, the ground is generally warmer than the air, and on hot days the ground is generally cooler than the air. So, on average, ground-coupled heat pumps should operate more efficiently than air-coupled designs.

Ground-coupled heat pumps are also called ground-source heat pumps, earth-coupled heat pumps, and geothermal heat pumps, though they really do not utilize geothermal energy in the classical sense. Instead of having their outside coils exchange heat with the air, they exchange heat with either a body of water, such as a river or lake (also called water-source heat pump), or with the earth, via a bored vertical hole or via horizontal trenching in the ground.

## HOW GROUND COUPLING WORKS

Instead of outside coils with a fan to circulate outside air, these units have a heat exchanger that facilitates heat transfer between the outside coil and an antifreeze solution. A pump circulates the antifreeze solution through buried pipes, where it is heated (winter) or cooled (summer) by the earth.

The pipes, typically made of polypropylene, can be buried in the earth in either of two ways: vertical bore holes or horizontal trenches. When using the hole method, one or more 6-inch diameter holes are drilled to a depth of 200 - 300 feet. In each hole, a pipe leads down and then loops back up to the surface, providing as much area as possible for heat transfer to take place. Typically, one borehole is needed for each ton of




**Ground coupling using horizontal trenches** *Coupling occurs with the earth through pipes buried in shallow trenches of 400 – 600 feet per ton of conditioning capacity required.*

air conditioning/heating capacity. When using the buried trench method, one or more are dug to a depth of about 6 feet. Typically, 400 – 600 feet of trench is needed for each ton of air conditioning/heating capacity.

Both methods require good contact between the pipe and the ground, so the holes or trenches are generally back filled with material like clay or fine soil. If multiple holes or trenches are dug, they are kept at least 15 feet apart.

## ECONOMICS AND ENVIRONMENT

A heat pump will generally use less than half the energy required by an electric resistance furnace, so it not only saves money, it also reduces emissions from fossil fuel power plants. In terms of emissions and fossil fuel consumption, it can actually surpass the performance of burning natural gas directly.

Compared to a standard air source heat pump, ground coupling adds another level of efficiency. But this is partially offset by the energy required to circulate the antifreeze solution, and of course, the initial cost of a ground-coupled unit will be higher. Therefore a cost analysis should be done to determine the lifetime energy savings as balanced against the higher initial cost.

Manufacturers of ground source heat pumps claim annual heating cost reductions of up to 50% and annual air conditioning cost reductions of up to 25%. The amount actually saved will depend on local climate and particular installation. Heating season savings will be more significant in colder climates, where air-source heat pumps are less effective because of the cold air temperatures. Cooling season savings will likewise be greater in the hotter climates.

## ORGANIZATIONS

**Geothermal Heat Pump Consortium, Inc.**
701 Pennsylvania Avenue, N.W.
Washington, D.C. 20004-2696
(888) 255-4436
**http://www.geoexchange.org/**

**International Ground Source Heat Pump Association**
Oklahoma State University
490 Cordell South
Stillwater, OK 74078
(800) 626-4747
**www.igshpa.okstate.edu**

**American Society of Heating, Refrigeration, and Air-Conditioning Engineers**
1791 Tullie Circle, NE
Atlanta, GA 30329
(404) 636-8400
**www.ashrae.org**

**Texas Renewable Energy Industries Association**
P.O. Box 16469
Austin, TX 78761-6469
(512) 345-5446
**www.treia.org**

## RESOURCES

**FREE TEXAS RENEWABLE ENERGY INFORMATION**
For more information on how you can put Texas' abundant renewable energy resources to use in your home or business, visit our website at **www.infinitepower.org** or call us at 1-800-531-5441, ext 3-1796. Ask about our free Teacher Resource Guides and CD available to teachers and home schoolers.

**ON THE WORLD WIDE WEB:**

**ENERGY STAR** labeled geothermal heat pumps:
**www.energystar.gov – go to search - enter geothermal heat pumps**

Information for prospective owners:
**www1.eere.energy.gov/geothermal/heatpumps.html**
**www.eere.energy.gov/RE/geo_heat_pumps.html**

**BOOKS:**

***Contractors and Geoexchange Heating and Cooling: A Profitable Combination.*** Geothermal Heat Pump Consortium, Washington, DC, 1998.

***Geothermal Heating and Cooling Systems.*** Electric Institute of Indians, 1996 (Available at 219-244-6111).

**RENEWABLE ENERGY**
THE INFINITE POWER
OF TEXAS

InfinitePower.org

**Financial Acknowledgement** This publication was developed as part of the Renewable Energy Demonstration Program and was funded 100% with oil overcharge funds from the Exxon settlement as provided by the Texas State Energy Conservation Office and the U.S. Department of Energy. Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

**State Energy Conservation Office**
111 East 17th Street, Room 1114
Austin, Texas 78774
Ph. 800.531.5441 ext 31796
www.InfinitePower.org

Texas Comptroller of Public Accounts
Publication #96-826 (08/06)